IIT JAM 2017 Chemistry (CY) Question Paper

Time Allowed :3 Hours	**Maximum Marks :**100	**Total questions :**60

General Instructions

General Instructions:

i) All questions are compulsory. Marks allotted to each question are indicated in the margin.

ii) Answers must be precise and to the point.

iii) In numerical questions, all steps of calculation should be shown clearly.

iv) Use of non-programmable scientific calculators is permitted.

v) Wherever necessary, write balanced chemical equations with proper symbols and units.

vi) Rough work should be done only in the space provided in the question paper.

1. The correct order of the boiling points of the compounds is

(A) CH_4 ¿ SiH_4 ¿ SnH_4 ¿ GeH_4

(B) SiH_4 ¿ CH_4 ¿ GeH_4 ¿ SnH_4

(C) SnH_4 ¿ GeH_4 ¿ CH_4 ¿ SiH_4

(D) SnH_4 ¿ GeH_4 ¿ SiH_4 ¿ CH_4

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2. In the following Latimer diagram, the species that undergoes disproportionation reaction is

$$MnO_4^- \xrightarrow{+0.56} MnO_4^{2-} \xrightarrow{+0.27} MnO_3^- \xrightarrow{+0.93} MnO_2 \xrightarrow{+0.15} Mn_2O_3 \xrightarrow{-0.25} Mn(OH)_2 \xrightarrow{-1.56} Mn$$

(A) MnO_4^{2-}

(B) MnO_3^-

(C) Mn_2O_3

(D) $Mn(OH)_2$

---

3. A yellow precipitate is formed upon addition of aqueous $AgNO_3$ to a solution of

(A) phosphite

(B) pyrophosphate

(C) metaphosphate

(D) orthophosphate

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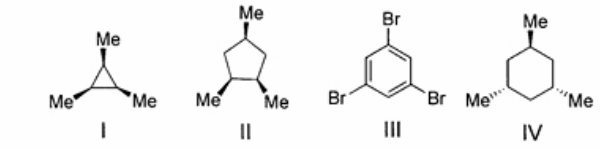
4. The compounds having C_3-axis of symmetry are



(A) I, III and IV

(B) I, II and III

(C) I and III

(D) III and IV

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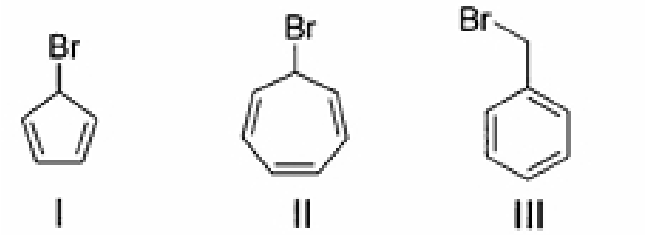
5. The correct order of rate of solvolysis for the following compounds is



(A) III ¿ II ¿ I

(B) II ¿ I ¿ III

(C) III ¿ I ¿ II

(D) II ¿ III ¿ I

---

6. In the following sequence of reactions, the overall yield (%) of O is

$L \xrightarrow{92\%} M \xrightarrow{78\%} N \xrightarrow{85\%} O$

(A) 61

(B) 85

(C) 74

(D) 68

---

7. Catalytic hydrogenation of the following compound produces saturated hydrocarbon(s). The number of stereoisomer(s) formed is

(Structure as given in the question)

(A) 1

(B) 2

(C) 3

(D) 4

---

8. The number of normal modes of vibration in naphthalene is

(A) 55

(B) 54

(C) 48

(D) 49

---

9. The number of degrees of freedom of liquid water in equilibrium with ice is

(A) 0

(B) 1

(C) 2

(D) 3

---

10. A straight line having a slope of $-\Delta U^0/R$ is obtained in a plot between

(A) lnK_p versus T

(B) lnK_c versus T

(C) lnK_p versus 1/T

(D) lnK_c versus 1/T

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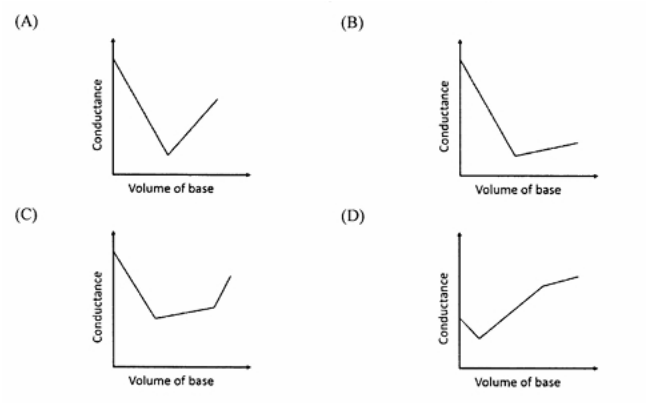
11. In a typical conductometric titration of a strong acid with a weak base, the curve resembles

(Conductance vs volume of base graphs as shown in the question)



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12. The coordination number of Al in crystalline $AlCl_3$ and liquid $AlCl_3$, respectively, is

(A) 4 and 4

(B) 6 and 6

(C) 6 and 4

(D) 3 and 6

---

13. The homogeneous catalyst used in water-gas shift reaction is

(A) $PdCl_2$

(B) Cr_2O_3

(C) $[RhCl(PPh_3)_3]$

(D) $[RuCl_2(bipyridyl)_2]$

---

14. Nitrosyl ligand binds to d-metal atoms in linear and bent fashion and behaves, respectively, as

(A) NO^+ and NO^+

(B) NO^- and NO^-

(C) NO^- and NO^+

(D) NO^+ and NO^-

15. The metal ion (M^{2+}) in the following reaction is

$$M^{2+} + S^{2-} \longrightarrow \text{Black precipitate} \xrightarrow{\text{hot conc. } HNO_3} \text{White precipitate}$$

(A) Mn^{2+}

(B) Fe^{2+}

(C) Cd^{2+}

(D) Cu^{2+}

---

16. The correct order of wavelength of absorption (λ_{max}) of the Cr-complexes is (en = ethylenediamine)

(A) $[CrF_6]^{3-}$ ¿ $[Cr(H_2O)_6]^{3+}$ ¿ $[Cr(en)_3]^{3+}$ ¿ $[Cr(CN)_6]^{3-}$

(B) $[Cr(H_2O)_6]^{3+}$ ¿ $[CrF_6]^{3-}$ ¿ $[Cr(en)_3]^{3+}$ ¿ $[Cr(CN)_6]^{3-}$

(C) $[Cr(CN)_6]^{3-}$ ¿ $[Cr(en)_3]^{3+}$ ¿ $[Cr(H_2O)_6]^{3+}$ ¿ $[CrF_6]^{3-}$

(D) $[Cr(en)_3]^{3+}$ ¿ $[Cr(CN)_6]^{3-}$ ¿ $[Cr(H_2O)_6]^{3+}$ ¿ $[CrF_6]^{3-}$

---

17. The correct order of enthalpy of hydration for the transition metal ions is

(A) Cr^{2+} ¿ Mn^{2+} ¿ Co^{2+} ¿ Ni^{2+}

(B) Ni^{2+} ¿ Co^{2+} ¿ Mn^{2+} ¿ Cr^{2+}

(C) Ni^{2+} ¿ Co^{2+} ¿ Cr^{2+} ¿ Mn^{2+}

(D) Cr^{2+} ¿ Mn^{2+} ¿ Ni^{2+} ¿ Co^{2+}

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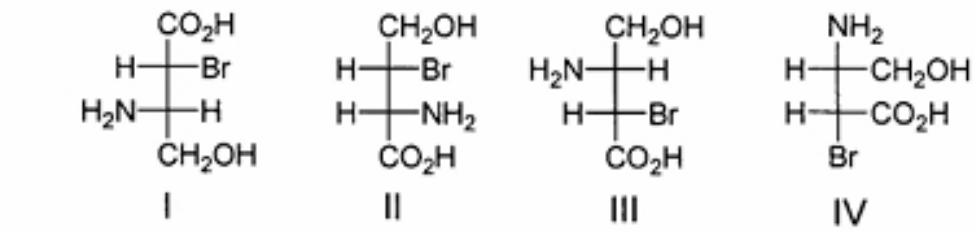
18. Among the following compounds, the pair of enantiomers is



(A) I and IV

(B) I and III

(C) II and III

(D) III and IV

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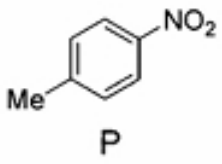
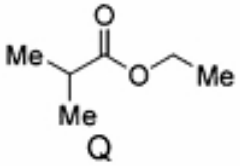
19. The number of proton NMR signals for the compounds P and Q, respectively, is



P



Q

(A) 3 and 4

(B) 3 and 5

(C) 4 and 3

(D) 5 and 4

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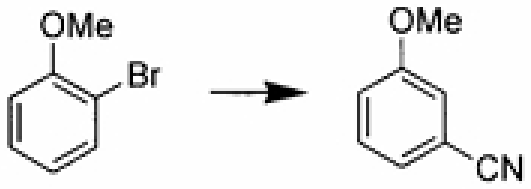
20. The correct set of reagents for the following conversion is



(A) (i) $NaNH_2$/liq. NH_3; (ii) $NaNO_2$/dil. HCl; (iii) CuCN, heat

(B) (i) HNO_3/H_2SO_4; (ii) Zn/HCl; (iii) $NaNO_2$/dil. HCl; (iv) CuCN, heat

(C) (i) Mg/ether, H_3O^+; (ii) $(EtO)_2CO$; (iii) NH_2OH; (iv) PCl_5

(D) (i) Mg/ether, H_3O^+; (ii) HNO_3/H_2SO_4; (iii) $NaNO_2$/dil. HCl; (iv) CuCN, heat

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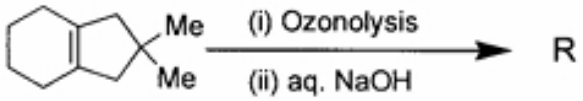
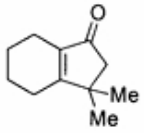
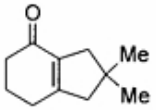
21. The product R in the following reaction is



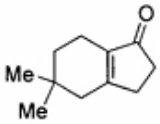
(A)



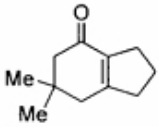
(B)



(C)



(D)



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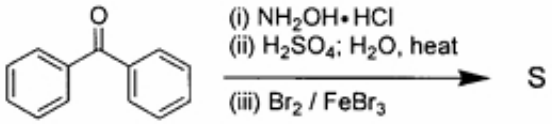
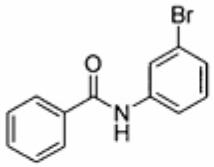
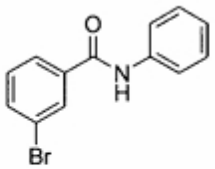
22. The major product S of the following reaction is



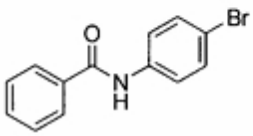
(A)



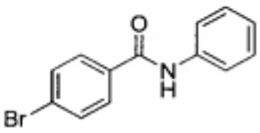
(B)



(C)



(D)



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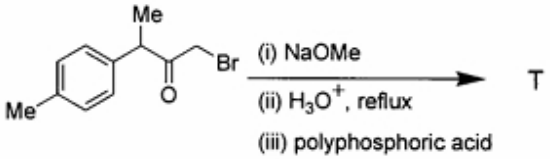
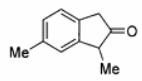
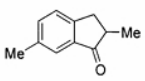
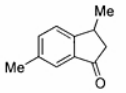
23. In the following reaction, the major product T is

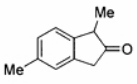


(i) NaOMe (ii) H_3O^+, reflux (iii) Polyphosphoric acid

(A) 

(B) 

(C) 

(D) 

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24. The following conversion is carried out using

(A) hydroboration–oxidation followed by Jones oxidation

(B) Wacker oxidation followed by haloform reaction

(C) oxymercuration–demercuration followed by Jones oxidation

(D) ozonolysis followed by haloform reaction

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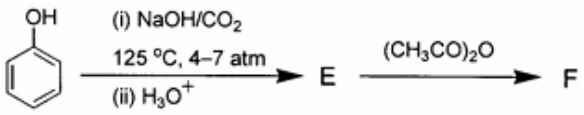
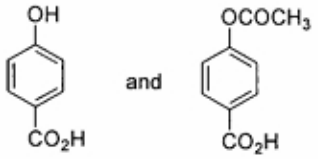
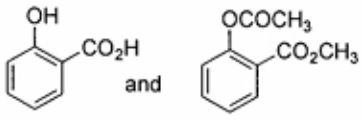
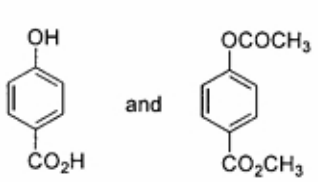
25. In the following reactions, the major products E and F, respectively, are

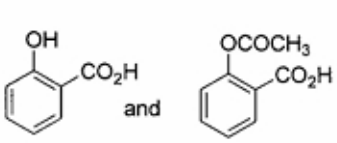
(i) $NaOH/CO_2,\ 125°C,\ 4–7$ atm (ii) H_3O^+ $\longrightarrow E$ $(CH_3CO)_2O \longrightarrow F$



(A) 

(B) 

(C) 

(D) 

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26. $\frac{dy}{dx} = -\frac{y}{x}$ **is a differential equation for a/an**

(A) circle

(B) ellipse

(C) bell-shaped curve

(D) hyperbola

---

27. Value of the given determinant is

$$\begin{vmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & 0 & 2 \end{vmatrix}$$

(A) -12

(B) 0

(C) 6

(D) 12

---

28. Ionisation energy of hydrogen atom in ground state is 13.6 eV. The energy released (in eV) for third member of Balmer series is

(A) 13.056

(B) 2.856

(C) 0.967

(D) 0.306

---

29. For a first order reaction $A(g) \rightarrow 2B(g) + C(g)$**, the rate constant in terms of initial pressure** p_0 **and pressure at time** t **(**p_t**), is given by**

(A) $\frac{1}{t} \ln \frac{p_0}{p_t - p_0}$

(B) $\frac{1}{t}\ln\frac{2p_0}{3p_0-p_t}$

(C) $\frac{1}{t}\ln\frac{3p_0}{p_t-p_0}$

(D) $\frac{1}{t}\ln\frac{3p_0}{3p_t-p_0}$

---

30. For a particle in a one-dimensional box of length L with potential $V(x)=0$ for $0<L>x>0$ and $V(x)=\infty$ otherwise, an acceptable wave function consistent with the boundary conditions is

(A) $A\cos\left(\frac{n\pi x}{L}\right)$

(B) $B(x+x^2)$

(C) $Cx^3(x-L)$

(D) $\frac{D}{\sin\left(\frac{n\pi x}{L}\right)}$

---

31. The "heme" containing protein(s) is/are

(A) cytochrome C

(B) hemocyanin

(C) hemerythrin

(D) myoglobin

---

32. Among the following, the species having see-saw shape is/are

(A) SF_4

(B) XeF_4

(C) ClF_4^-

(D) ClF_4^+

---

33. The indicator(s) appropriate for the determination of end point in the titration of a weak acid with a strong base is/are

(A) phenolphthalein

(B) thymol blue

(C) bromophenol blue

(D) methyl orange

---

34. Jahn-Teller distortion is observed in octahedral complexes with d-electron configuration of

(A) d^5 high spin

(B) d^5 low spin

(C) d^6 high spin

(D) d^4 low spin

---

35. Among the following, the correct statement(s) is/are

(A) Guanine is a purine nucleobase

(B) Glycine and proline are achiral amino acids

(C) DNA contains glycosidic bonds and pentose sugars

(D) Sucrose is a non-reducing sugar

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36. The INCORRECT statement(s) among the following is/are

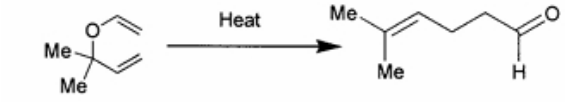
(A) [$4\pi + 2\pi$] cycloaddition reactions are carried out in presence of light

(B) [$2\pi + 2\pi$] cycloaddition reaction between a keto group and an alkene is photochemically allowed

(C) [$4\pi + 2\pi$] cycloaddition reactions are thermally allowed

(D) Transoid dienes undergo Diels-Alder reactions

37. The following conversion is an example of



(A) oxy-Cope rearrangement

(B) sigmatropic rearrangement

(C) Claisen rearrangement

(D) pericyclic reaction

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38. IR active molecule(s) is/are

(A) CO_2

(B) CS_2

(C) OCS

(D) N_2

---

39. Intensive variable(s) is/are

(A) temperature

(B) volume

(C) pressure

(D) density

---

40. Wave nature of electromagnetic radiation is observed in

(A) diffraction

(B) interference

(C) photoelectric effect

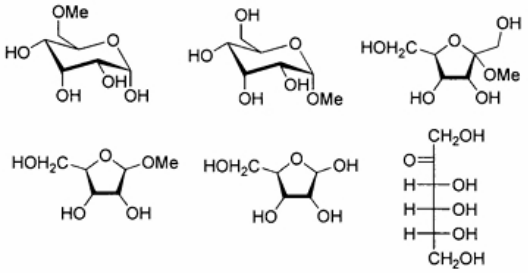
(D) Compton scattering

41. The number of isomeric structures of di-substituted borazine ($B_3N_3H_4X_2$) is .....

42. The number of S–S bond(s) in tetrathionate ion is .....

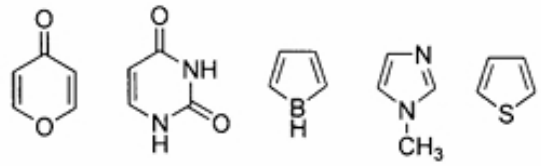
43. The number of unpaired electron(s) in K_2NiF_6 is .....

44. The number of reducing sugars among the following is .....



45. The maximum number of dipeptides that could be obtained by reaction of phenylalanine with leucine is .....

46. Among the following, the number of aromatic compound(s) is .....



47. At an operating frequency of 350 MHz, the shift (in Hz) of resonance from TMS of a proton with chemical shift of 2 ppm is .....

48. At 298 K and 1 atm, the molar enthalpies of combustion of cyclopropane and propene are 2091 kJ mol^{-1} and 2058 kJ mol^{-1}, respectively. The enthalpy change (in kJ mol^{-1}) for the conversion of one mole of propene to one mole of cyclopropane is .....

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49. For a cell reaction, Pb(s) + Hg_2Cl_2(s) $\rightarrow$ $PbCl_2$(s) + 2Hg(l), $\left(\frac{\partial E^\circ}{\partial T}\right)_P$ is 1.45 × 10^{-4} V K^{-1}. The entropy change (in J mol^{-1} K^{-1}) for the reaction is .....

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50. For a reaction 2A + B $\rightarrow$ C + D, if rate of consumption of A is 0.1 mol L^{-1} s^{-1}, the rate of production of C (in mol L^{-1} s^{-1}) is .....

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51. The standard reduction potentials of Ce^{4+}/Ce^{3+} and Fe^{3+}/Fe^{2+} are 1.44 and 0.77 V, respectively. The $\log_{10}K$ (K is equilibrium constant) value for the following reaction is ..... (final answer should be rounded off to two decimal places)

$$Ce^{4+} + Fe^{2+} \rightleftharpoons Ce^{3+} + Fe^{3+}$$

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52. A radioactive element undergoes 80% radioactive decay in 300 min. The half-life for this species in minutes is .....

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53. Silver crystallizes in a face-centered cubic lattice. The lattice parameter of silver (in picometer) is .....

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54. The amount of bromine (atomic wt. = 80) required (in gram) for the estimation of 42.3 g of phenol (molecular wt. = 94 g mol^{-1}) is .....

55. The total number of pair of enantiomers possible with molecular formula $C_5H_{12}O$ is .....

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56. In 200 g of water, 0.01 mole of NaCl and 0.02 mole of sucrose are dissolved. Assuming solution to be ideal, the depression in freezing point of water (in °C) will be _____ (final answer rounded off to two decimal places).

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57. The adsorption of a gas follows the Langmuir isotherm with $K = 1.25$ kPa^{-1} at 25 °C. The pressure (in Pa) at which the surface coverage is 0.2 is _____

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58. The separation of 123 planes (in nm) in an orthorhombic cell with $a = 0.25$ nm, $b = 0.5$ nm, $c = 0.75$ nm is _____ (round to two decimals).

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59. A vessel contains a mixture of H_2 and N_2 gas. The density of this gas mixture is 0.2 g L^{-1} at 300 K and 1 atm. Assuming ideal gas behavior, the mole fraction of N_2 (g) in the vessel is _____ (final answer to two decimals).

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60. Consider an isothermal reversible compression of one mole of an ideal gas in which the pressure of the system is increased from 5 atm to 30 atm at 300 K. The entropy change of the surroundings (in J K^{-1}) is _____ (final answer rounded to two decimals).
